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ABSTRACT
OF
REPORT OF AERIAL SPRAY OPERATIONS
IN THE
CONTINENTAL UNITED STATES IN 1946.

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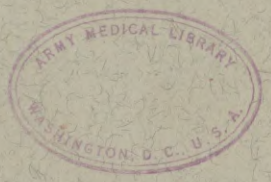

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REPORT OF AERIAL SPRAY OPERATIONS IN THE CONTINENTAL UNITED STATES IN 1946

Introduction: Studies of the application of insecticides from aircraft for practical mosquito and fly control have involved work on the proper equipment, types of preparations (sprays and dusts), particle size, and dosage rates. Work was initiated by the Orlando Laboratory of the Bureau of Entomology and Plant Quarantine in 1942 in cooperation with the Army Air Forces to develop more suitable dispersal apparatus for DDT in the control of mosquito adults and larvae. In the early work, emphasis was placed on developing methods for spraying with aircraft in combat zones. These studies created a widespread interest over a period of about three and one-half years, 1942 to 1945. Various government agencies took part in these studies and made contributions of value. The most active agencies conducting work on the problem are the following: War Department, including the Office of The Surgeon General, the Chief of Engineers, the Army Air Forces, and the Chief of the Chemical Corps; U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine; Navy Department, Bureau of Medicine and Surgery; the U. S. Coast Guard; The Tennessee Valley Authority; and the National Defense Research Committee.

Early work included development of a venturi type sprayer built for a cub aircraft (L-4b). The spray tank had a capacity of 25 gallons, and pressure was provided with a wind driven propeller mounted on a herringbone gear pump ($\frac{1}{2}$ inch). This supplied liquid spray to a boom having six fern-type nozzles. Spray was applied at the rate of about 2 quarts per acre with a swath width of about 40 feet. A similar unit was developed for use on the PT-17 aircraft (Stearman). The venturi type sprayer proved rather unsatisfactory and the breaker bar unit was developed and recommended for light aircraft.

Tests were conducted also on the adaptation of the M-10 tank of the Chemical Warfare Service and similar apparatus for use on medium bomber aircraft such as the A-20. The tank capacity was 32 gallons and the effective swath width 300 to 400 yards. This type of spray apparatus was used on medium bombers for the spraying of beachheads and other infested areas in the Pacific campaigns of 1944 and 1945.

In addition to the above mentioned aircraft, the C-47 and the B-25 were used in overseas theaters for dispersal of insecticide sprays. Equipment developed for the C-47 consisted of a 625 gallon storage tank mounted in the plane with straight discharge pipe. A release valve operated manually by the aerial engineer was used to release the spray.

Prior to 1945 no policy existed in the Army for the dispersal of insecticides by aircraft at military installations in the continental United States. War Department Circular 207, part VI.

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mosquito control, 10 July 1945, contained the initial policy for the regulation of this type of work. Under this directive all projects submitted by posts for spraying by aircraft were reviewed and approved or rejected by the Army Committee for Insect and Rodent Control. Each installation obtaining the approval for an aerial spray project provided the aircraft and spraying apparatus necessary for the work. Practically all spraying in 1945 in the continental United States was done with small aircraft of the Pt-17 and L-5 types.

Experience gained in 1945 indicated that for aerial spraying to be successful more supervision must be exercised in the preparation of projects, selection of planes and spray apparatus, and selection of personnel for the work. Therefore War Department policy for aerial spraying was revised for 1946. Changes included a more careful preparation of project requests, a review of all projects by entomologists of the Corps of Engineers, and the designation of a single agency of the AAF to conduct control operations. The revised policy for 1946 is contained in War Department Circular 78, Section III, Insect Control, March 1946. The operational agency designated by the Commanding General, Army Air Forces to conduct spraying operations in 1946 was Squadron D, 303rd AAF Base Unit (later 313th AAF Base Unit), Greenville Army Air Base, Greenville, South Carolina. Report of operations by this unit follows:

1. OBJECT: Object of this report is to summarize the 1946 season's activities and to make recommendations which might be of value for future planning for dispersal of insecticides by aircraft.

2. ORGANIZATION: Squadron D was organized as a letter squadron of the 303rd. AAF Base Unit, Greenville Army Air Base, South Carolina. It was charged with the mission of insect control. The squadron was immediately attached to the 434th. Troop Carrier Group and further attached to a squadron of that group for administration, rations, quarters, supply, and duty.

When the 434th. Troop Carrier Group was reorganized as a squadron, Squadron D was relieved from attachment to the group and assignment to 303rd. AAF Base Unit and was assigned to the 313th. AAF Base Unit at Greenville Army Air Base and attached to Squadron A, 313th. AAF Base Unit for rations and supply.

3. PERSONNEL:

A. Sequence 20 of the 303rd. AAF Base Unit Manning Table was Table of Organization approved for the Insect Control Organization by Headquarters, AAF. Table below indicates the personnel authorized and the personnel actually assigned the organization.

JOB TITLE	SSN	NUMBER AUTHORIZED	NUMBER ASSIGNED
COMMISSIONED OFFICERS			
Pilot, TE	1051	6	6
Operations Off AF	2161	1	1
Entomologist (Medical Dept.)	3315	2	2
A/C Maint Off	4823	1	0
ENLISTED PERSONNEL			
Technical Aide	170	1	0
Clerk-typist	405	2	2
Auto Equip Oper	345	2	2
A/C & Eng Mech	747	7	6
AAF Supply Tech	826	1	1
Supply Clerk	835	1	0
Aerial Engineer	2750	3	3
Radio Operator	2756	3	3

B. Remarks:

(1) Two clerk-typists, one aerial engineer, and one airplane and engine mechanic were transferred for shipment overseas and were never replaced. This caused particular hardship on the squadron since the clerk-nontypist who replaced the clerk-typists had to be trained on the job.

(2) Since the aircraft used by Squadron D were assigned to and maintained by other units, the maintenance personnel assigned to Squadron D were assigned for duty to the engineering section maintaining the aircraft.

(3) When Squadron D was assigned to the 313th. AAF Base Unit and attached to Squadron A for rations and supply, it was necessary for Squadron D to do its own administration. Because only one clerk was assigned to the unit, much of the time which should have been utilized typing up spray data and additional information for the project reports was actually consumed doing administrative details. This also presented a situation whereby in case of furlough or disability of the clerk-typist, no trained clerk was available to continue with the

typing and orderly room procedure. Since the personnel assigned the unit were chosen for their ability as aircrew members or because of their entomological training, trained office personnel were not available. An additional one or two trained clerks would have alleviated the situation.

C. Recommendations from an administrative viewpoint:

(1) That the Aerial Spray Squadron be redesignated a flight and assigned to a squadron with the flight leader directly responsible to the Squadron CO. Advantages of this method of organization would be:

a. Better coordination and understanding between administration, supply, maintenance, and operations if the Squadron CO is responsible for all sections.

b. The officers and enlisted men would be administered through a well organized and trained orderly room and personnel section able to keep up with changes in regulations and other directives. This would tend to keep the morale of the men at a higher level. It is believed the average squadron orderly room and personnel section could accomplish additional work entailed with very little additional effort.

c. The flight leader would be relieved of the details of personnel administration and could devote a greater portion of his time and efforts to directing the aerial spray activities of the unit.

d. Since it is improbable that an engineering officer and a completely equipped tech supply could be provided for the maintenance of only 3 to 5 aircraft, the unit must of necessity be attached to another organization for maintenance. If the aerial spray unit were a flight in another organization, such as a squadron, maintenance and tech supply organization already set up could be utilized.

e. Personnel with critical MOS's such as 4823, 405, and 826 could be utilized with greater efficiency.

(2) Should the aerial spray unit be organized as a squadron for next season's work and attached to another squadron for rations, quarters, duty, maintenance, and supply which would closely resemble the set up the first part of the 1946 season, the following changes in the assignment of personnel are recommended.

a. An officer MOS of 2110, adjutant, be assigned in order that one officer be present in the orderly room at all times during duty hours and not be required to participate in spraying missions.

b. At least two 405's be assigned.

c. Personnel with MOS's of 826, 835, and 4823 not be assigned.

d. One 590, general duty soldier, be assigned for each airplane to assist the radio operator in placing ground markers.

e. An enlisted man having an MOS of 170 be provided to assist entomologists in collecting and correlating entomological data requested by higher authorities.

f. An entomologist to accompany each spray plane be provided in order that intelligent decisions concerning entomological aspects might be arrived at in the field and to assist post entomologists in collecting entomological and biological data which might be of value in determining future policies concerning airplane spraying.

4. TRAINING:

A. Back-ground of key personnel:

(1) Entomologists:

Capt. Henry A. Dunn, SnC--BS in Entomology
1 year 4 months experience in aerial spraying of DDT in Central and West Africa with B-25, C-47, L-4, and Gypsy type aircraft

Capt. Oscar V. Lopp, SnC--MS in Entomology

(2) Pilots: All pilots assigned Squadron D were veteran troop carrier pilots with from 500 to 3,000 hours flying time the greater part of which was obtained while flying C-47 type aircraft. Only one pilot, however, had previous experience in aerial spraying of DDT.

B. Training prior to the organization of Squadron D:

At the request of the Office of the Chief of Engineers and before Squadron D was activated, key personnel (pilots and entomologists) were ordered to Orlando, Florida on TDY with

the AAF Committee on Aerial Dispersal of Insecticides. The purpose of the TDY was to enable the above mentioned personnel to become familar with materials, and methods employed by the committee in dispersing DDT by plane. Pilots were on TDY for a five day conference which was also attended by the Squadron entomologists. The entomologists were on duty with the committee for a longer period of time--Capt. Dunn 1 month; Capt. Lopp 2½ months.

Representatives of the Corps of Engineers, Army Medical Department and U. S. Public Health Service at the five day conference conducted by the AAF CADI under the direction of Major Joseph C. Goldsmith were:

Mr. Stephen S. Easter, Entomologist, Hq Second Army, Baltimore, Md.
Mr. Theophil Haack, Entomologist, Hq Second Army Sub Office Columbus, Ohio
Mr. Virgil Miles, Entomologist, Hq Fifth Army, Chicago, Ill.
Mr. Clell B. Wisecup, Entomologist, Hq Fifth Army Sub Office Omaha, Neb.
Mr. Myles F. Bowen, Entomologist, Hq Sixth Army, San Francisco, Cal.
Mr. Kent S. Littig, Entomologist, Hq Seventh Army, Atlanta, Ga.
Mr. John H. Robinson, Entomologist, Hq Air Training Command, Barksdale Field, Shreveport, La.
Mr. William D. Reed, Chief, Insect and Rodent Control Section, Office of the Chief of Engineers, Washington, D. C.
Mr. Ralph W. Bunn, Assistant Chief, Insect and Rodent Control Section, Office of the Chief of Engineers. Washington, D. C.
Capt. Charles Spencer, Sanitary Engineer, Surgeon General's Office, Washington, D. C.
Lt. Col. George H. Bradley, Entomologist, US Public Health Service, Atlanta, Ga.

A considerable portion of the five day conference period was used explaining the capabilities and limitations of DDT as an insecticide for controlling mosquitoes and various other insects. The history and chemistry of DDT, method to be used to request aerial spray, justification of aerial spray, precautions which should be observed while spraying DDT over large areas, etc. were also discussed. Very little information as to the flying technique which should be used by the pilots, markers found effective, loading equipment recommended, or length of effective mosquito control per application was presented. This information had to be obtained from other sources after the Squadron was activated.

C. Training accomplished after the unit was organized:

(1) Development of spraying technique:

a. In order to utilize existing information on spraying technique and marking swath width, bulletins and

reports treating on the subject were obtained and sifted for information which might be of assistance. Those which proved to be of the most value were:

TB-MED-200 "Spraying of DDT from Aircraft"

"Report of test conducted by AAF Tactical Center to determine suitability of especially designed spray equipment for dissemination of DDT from B-25 and C-47" (AAF Board project No. 4095BG725) dated 11 April 45

"Report of development and test of spray equipment for L-5 aircraft for dissemination of insecticide DDT" conducted by AAF Center Orlando, Florida under Project No. 4469B452.26 Report dated 5 June 45.

"Insecticides and Insect Repellents developed for the Armed Forces at the Orlando, Florida Laboratory" Committee on Medical Research of the National Research Council's interim report No. O-100 (NRC Insect Control Committee Report No. 100.)

Also reports on aerial spraying activities during the 1945 insect season conducted at Fort Leavenworth, Fort Knox, and Savanna Ordnance Depot.

In order to evaluate the information obtained from the above sources, to develop new methods, and to train unit personnel, a special area of the Fort Benning Reservation was made available to the unit over which low altitude flights could be conducted. The area was considered to be representative of the type of terrain over which most of the season's spray flights would be made. Several extended trips were made from Greenville Army Air Base to Lawson Field for the purpose of conducting training and testing missions on the practice area. The objective of these trips was three fold: (a) to acquire assurance that through pilot training and a system of ground markers the pilots could fly precise 100 yard swath widths while spraying at extremely low altitude and therefore unable to naviagate by normal means. (b) to devise and test several media of air-ground communication usable in the field. (c) To train ground marker crews. The various ground marker signals which were tried on these training flights were: panels, hydrogen balloons (various colors),

pistol flares, and various colored smoke grenades. The advantages and disadvantages of each are mentioned under signal equipment.

(2) Other phases:

a. Orientation lectures concerning the mission of the unit were given the enlisted personnel in order to stimulate interest in the project.

b. Enlisted personnel who were to be used as ground marker crews were briefed as to the necessity for the pilots to fly accurate 100 yard swath widths and the importance of correctly placed ground markers. These persons were also instructed as to how and where to place the markers in order that the pilots might see them.

5. EQUIPMENT AND MATERIALS:

A. Aircraft:

(1) Authorization: AAF letter subject, "DDT Spraying Project", dated 6 September 45 authorized Hq Third Air Force to provide not more than three C-47's and three L-5's for the use of the insect control unit.

(2) Assignment: C-47 aircraft with spray equipment installed were assigned to the 434th. Troop Carrier Group for the use of Squadron D effective on the following dates: Aircraft number 43-15565 on 22 April 46; aircraft number 43-16093 on 8 July 46; and aircraft number 42-92108 on 10 July 46.

(3) Condition of aircraft: The condition of these aircraft upon their assignment to the 434th.TC Group was a definite factor contributing to the delay from the time they were assigned to the time they were actually available for a spray mission. This was particularly true of aircraft 42-92108 which although assigned to the 434th. TC Group on 10 July 46, was not available for spray missions until 18 September 46. A list of some 65 discrepancies was found on the acceptance check by technical inspectors of the 71st. TC Squadron, 434th. TC Group.

(4) Comment: Aerial spraying with C-47 aircraft proved throughout the season's work to be entirely feasible and not unduly hazardous. However, pilots chosen for this work should be screened to eliminate foolhardy and careless personnel.

This type aircraft offers the advantage over bomber and fighter type aircraft of being comparatively simple to

maintain in addition to being so constructed as to provide cargo space for loading equipment and the ferrying of additional personnel to assist in the spray operation.

At the beginning of the season pilot fatigue was evident after one hour flying spraying time. However, as the season progressed and more experience was gained. pilots were able to spray for two hours without undue symptoms.

(5) Recommendations:

a. That C-47 aircraft be used in accomplishing next season's spray work.

b. That in the interest of providing an additional safety factor for the low altitude flying involved, the safety features for emptying the spray tank recommended under airplane equipment be installed prior to the 1947 season.

c. That consideration be given to the fact that C-47 aircraft are becoming obsolete in the Army Air Forces and therefore serious problems regarding procurement of repair and replacement parts will possibly be encountered during next season.

B. Aircraft equipment:

(1) Description: The DDT dispersing equipment utilized by Squadron D consists of a gravity flow system involving the use of a large storage tank in the aircraft with the necessary fittings connecting the reservoir tanks to a streamlined discharge pipe and incorporating an electrically controlled shut-off valve operated from the pilot's compartment.

(2) Aircraft reservoir: The aircraft DDT reservoir used in C-47 aircraft operated by this unit is an A-26 ferry fuel tank (See Fig. 1) with a capacity of 675 gallons and is installed in the cabin or cargo compartment. This tank is rectangular in shape having the following dimensions: 13½ feet long, 3¼ feet wide, 2-1/3 feet high. When installed in the aircraft the tank covers a considerable portion of the floor space and leaves very little room for cargo. For this reason, the aircraft cannot be efficiently utilized as a cargo carrier while equipped for spraying. However, as the tanks are installed in aircraft of the unit, there is undisturbed seating facilities for 18 persons. The tank is filled through a three (3) inch filling and vent pipe (See Fig. 2) with the opening located outside of the aircraft and above the right wing for easy access.

(3) DDT dispersing equipment: It is the understanding of personnel of Squadron D that the original blueprints for the DDT dispersing equipment to be utilized by this organization were obtained from the AAF Committee on Aerial Dispersal of Insecticides and sent to Wright Field where the actual installation on aircraft 43-15565 was to be made. Kits for the other two planes were to be made at Wright Field and installed in the field by The Third Air Force. The original blueprints called for a four (4) inch pipe connecting the storage tank with the discharge outlet. A poppet shut-off valve of sufficient size to permit full flow through this pipe was to be installed in the four inch pipe line. The actual rate of flow was to be controlled up to the capacity of the four inch pipe by varying the size of the thirty inch long streamlined discharge pipe (See Fig. 4) attached. Three such pipes of varying sizes were to be included in each kit. Equipment of this design would permit a considerable variance of dosage up to 2 pounds or more of DDT per acre. However, for reasons unknown to this unit, the blueprints provided were not used. The equipment actually provided, divided into the two modifications is described as follows:

a. Aircraft 43-15565 was the first aircraft assigned to the unit. The dispersing installation upon its arrival consisted of the standard tank mentioned above with one, one inch pipe leading from the tank through an electric shut off valve to a one inch discharge pipe. Only one discharge pipe was provided, it being only 16 inches long. It was found desirable to lengthen the pipe to prevent the fuselage from interferring with the spray plume and to discharge the spray at a place where the propeller wash would increase dispersion. The discharge pipe was lengthened locally. In the process of lengthening the spray pipe the size of the outlet was reduced to 7/8 inch without consulting this unit. The dosage delivered with this installation averaged 0.24 pounds of DDT per acre. This was 0.06 pounds less than the desired dosage. Because this aircraft was the only one available for missions at this time, the equipment was not remodified.

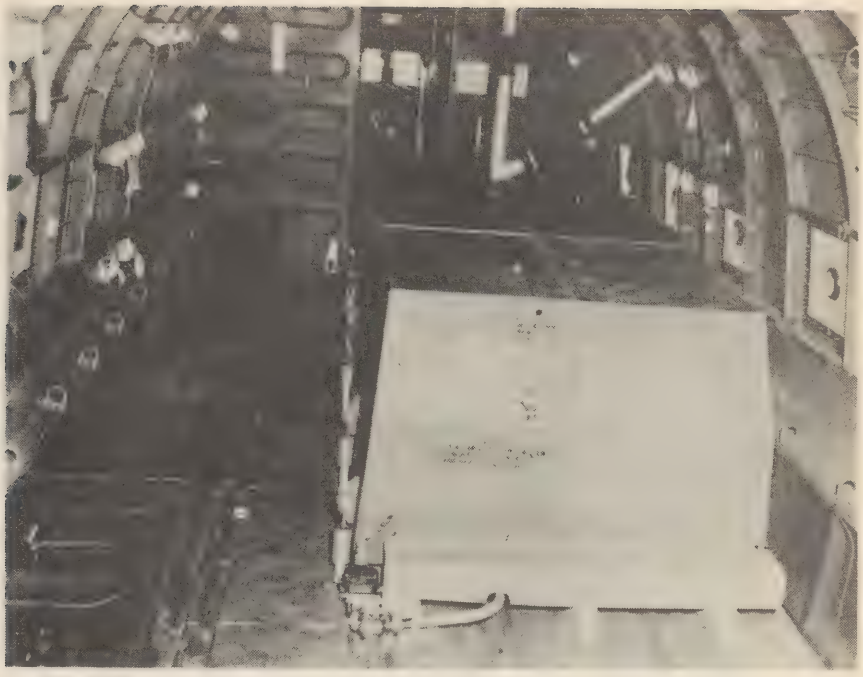

Fig. 1 DDT Fuselage Tank

Fig. 2 Air vent to DDT tank (straight up)
and filling tube (right)

Fig. 3 Electrically operated valve in DDT outlet line

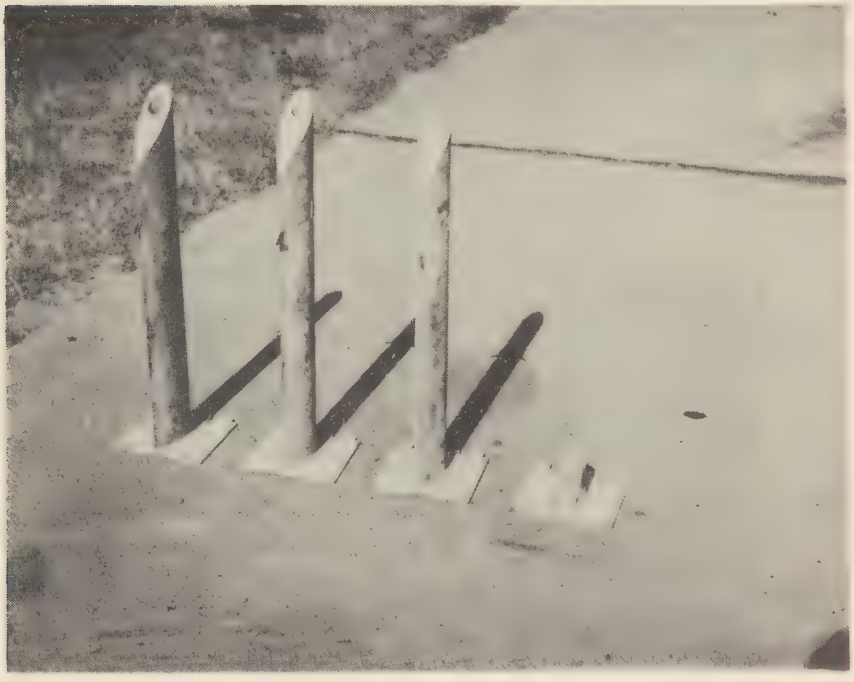

Fig. 4 Discharge nozzles of different diameter for varying dosage

b. After observing the limitations of the equipment on aircraft 43-15565, action was taken to have the equipment which was to be installed in the other two aircraft (43-16093 and 42-92108) modified to increase the capacity of the line from the tank to the discharge outlet. Three discharge pipes 30 inches in length with inside diameters of 7/8 inch, 1 inch, and 1¼ inch were requested for each of the two planes. The depot making the installations was unable to acquire larger valves, so in order to expedite the installation, two one inch pipes were installed from the tank through two separate one inch electrically operated valves to a Y connection, thence to the discharge pipe. The shut-off valves (See Fig. 3) were controlled by two toggle switches (See Fig. 5) in the pilot's compartment. The discharge pipes on all aircraft are cut-off on a 45 degree angle on the dispersion end to prevent air pressure from reducing the flow. Three discharge pipes were provided with each of these two aircraft. The sizes were 3/4 inch, 7/8 inch, and 1-3/16 inch.

(4) Recommendations:

a. Since the equipment used this season proved satisfactory and was fexible enough to permit the desired degree of variance in dosage of DDT per acre, it is recommended that the same type equipment be retained for further use.

b. It is recommended that a method be devised whereby the DDT reservoir in the airplane can be very quickly emptied while in flight. If this safety factor were incorporated in the system, it would permit continued flight on one engine should the other fail. Considering the fact that spraying is accomplished at an altitude of 150 to 200 feet, the importance of being able to quickly release this load amounting up to 5,230 pounds cannot be overemphasized.

c. The DDT reservoir should be provided with a quantity gauge accurate enough to be used in determining the rate of flow obtained while in flight.

C. Insecticide:

(1) Nomenclature and quartermaster stock number: Insecticide, airplane spray, 20% DDT, Stock No. 51-I-155-30.

Fig. 5 Cock-pit switch that operates valve (fig. 3)

Fig. 6 Discharge nozzle (connected)

(2) Composition and description: The insecticide provided for the use of Squadron D consists of a DDT solution weighing approximately 7.75 pounds per gallon with composition as follows:

20% DDT by weight
52% Diesel Oil #2 by weight
28% Auxiliary solvent by weight (in this case Velsicol NR 70 or Culicide B)

(3) Procurement: The distribution of the original procurement of insecticide (15,000 gallons) was 3,000 gallons shipped to Greenville, South Carolina for the use of Squadron D and 12,000 gallons stored at Atlanta General Depot, Atlanta, Georgia. The latter was held in the Depot to be requisitioned when needed by Squadron D. The requisitions were made by telephone, and the DDT was shipped from Atlanta to the installation to be sprayed. This system has worked admirably and it is recommended that it be continued in any future spraying operations. The main drawback to this system is the undesirable length of time required to ship the insecticide from a central depot to spray sites throughout the country. This time ranged from 6 to 16 days in 1946, and averaged 12 days. A definite supply level, the amount depending upon the extensiveness of the season's program, should be maintained by the Depot in order to prevent the supply from becoming exhausted during the spraying season. This occurred during the past season and caused a curtailment of spraying operations. The depot obtained an additional 20,000 gallons of spray but not until it was too late in the season to be of any use for the current season.

(4) Total gallons used: During the past spraying season there was a total of 13,862 gallons of DDT spray used on the various spray projects.

(5) Recommendations: It is recommended that the DDT spray be handled in the same manner in any future operations. The operational agency, in this case Squadron D, should be the only unit allowed to requisition the spray and this should be accomplished by direct communication between Squadron D and the Depot concerned. In the event the spray program is to be greatly enlarged, the storage of DDT in several Depots rather than only the one at Atlanta should be considered. This would result in greater economy and a saving in time required for shipment. However, care should be taken to instruct any additional Depots authorized to handle the DDT the importance of expediting requisitions and to honor only requisitions submitted by the operational agency.

D. Loading equipment:

(1) Description: Due to the fact that the DDT made available to this squadron was in liquid form slightly heavier than #2

Diesel Oil and was barrelled in 55 gallon drums, the loading of the DDT into the aircraft presented quite a problem. The loading equipment used by Squadron D during the past season was a modified CWS Kit, mixing and transfer of thickened fuel, E2 R1. Chief components of the kit are air transformer and multiple take-off assembly (See Fig. 7) and fuel hose (with fittings and quick opening gate valve (See Fig. 8). The only additional equipment needed to augment this kit and not carried on missions by Squadron D is an air compressor which is readily available at all airfields and motor pools. Briefly the equipment is used as follows: The air compressor is attached to the air transformer which maintains the desired constant pressure; usually 35 pounds psi. The air under pressure maintained by the air transformer is connected by air hose to the 55 gallon drums of liquid DDT. The air, under desired pressure, entering the drums, forces the DDT out through the loading hose (See Fig. 11) and into the aircraft. (For loading operation, see Fig. 12.)

(2) Capacity: The above system after all connections are secured takes about 90 seconds to pump the DDT from one drum into the aircraft. The entire operation (completely loading the aircraft fuselage tank - capacity 675 gallons) takes approximately 45 minutes. The large time discrepancy shown here is consumed in connecting and disconnecting the equipment from one drum to the next. It takes 12 drums to fill the aircraft tank.

(3) Reliability: In all the time this equipment has been in use, it has never failed to function properly and efficiently. Neither the DDT nor the velsicol or culicide oil solvents of the mixture have produced any noticeable effects on the loading equipment or the rubber hoses.

(4) Waste: There have been times in the experiences of the squadron where, during the loading operations, as much as five gallons of DDT have been wasted. However, this was caused by inexperience and carelessness in handling the loading equipment. If care is exercised, experienced loading crews should have very little waste.

(5) Weight and bulk: All of the equipment of this kit can easily be stored in the DDT aircraft and flown to the project. The total weight, including the necessary tools, is approximately 150 pounds.

(6) Recommendations: Inasmuch as this kit was the only equipment extensively tried out by Squadron D, its merits cannot legitimately be compared with any other system. It can, however, be stated that this system always worked well, shows no deterioration due

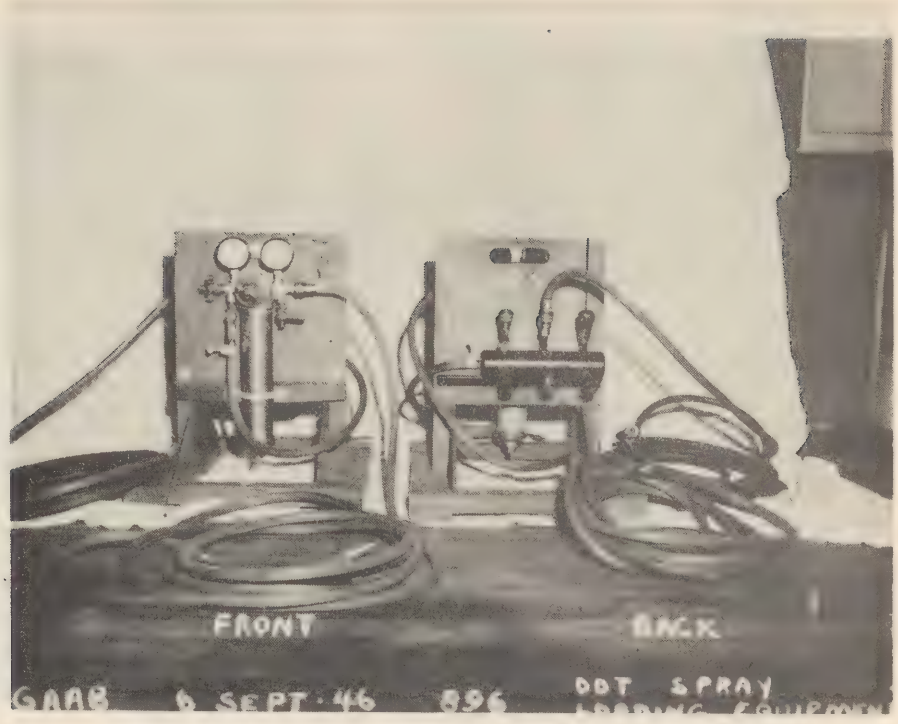

Fig. 7 Front and back view of air transformer

Fig. 8 DDT loading hose

Fig. 9 Pipes that go into the drums to which the DDT hose is connected. (See Fig. 11)

Fig. 10 Tools for opening drums

Fig. 11 Showing method of connecting hose to drum pipe.

Fig. 12 Loading operation

to chemicals used, and since it has no moving parts, will last indefinitely. It is nearly as fast in loading the aircraft as fuel transfer pumps without having the additional drawbacks of added weight, fire hazards, and temperamental nature of gasoline driven suction pumps.

It is therefore recommended that this type of equipment be continued in use until more extensive trials of other types be accomplished.

E. Signal equipment: Early in the season it was recognized that some form of communication between the air and ground was desirable. This was particularly true because of the need of helping the pilot make accurate swath widths. While flying at a high speed and low altitude it was next to impossible for the pilot to pick his markers and check points which would accurately determine the 100 yard swath intervals so vitally important to a successful spray treatment. For this reason, then, many types of communication were tried out, most of them unsuccessful for some reason or other. A short summary of the methods tested with their degree of success and their limitations follows.

(1) Radio: A SCR 624 was set up and gave good results. However, this type communication was abandoned after several trials due to the heavy weight and bulkiness of the set. A more mobile method was needed. Other radio sets which were available for use were either too heavy or, if light enough, did not have the range needed to be of assistance.

Radio sets SCR 536 were tried and although air-ground communication was impossible, they proved to be an aid to the various ground crews in keeping abreast with each other, and were thereafter utilized by Squadron D on most projects.

(2) Smoke grenades: Various colored smoke grenades No. HA-303-27 (white); 222415 (red); 222620 (yellow); 222520 (violet) were tried. Using them as markers on each end of spray runs proved they were easily discernible by the pilot and would greatly enhance the success of a mission. White smoke was determined to be most easily visible to the pilot and these smoke grenades (See Fig. 13.) were used throughout the season.

(3) Marked vehicle: A ground marker consisting of a vehicle with a flag attached or one with a sheet fastened over its top was tested to see if the pilot spraying could see it at great enough distance to accurately fly 100 yard swath widths by flying over the vehicle on each spray run. The vehicle of course was moved at 100 yard intervals. However, the difficulty in sighting the vehicle due to unfavorable terrain and tree cover caused this

Fig. 13 White smoke grenade

Fig. 14 Filling balloon with portable hydrogen generator

method to be inadequate in itself but when used with smoke grenades was found to be very satisfactory as a method of marking swaths.

(4) Hydrogen balloons: Hydrogen filled meteorological balloons anchored at a height of 100 feet were tried as a method of marking off the swaths for the pilots but due to the difficulty experienced in getting the balloons through trees and brush, the fact they would burst very easily, and the necessity to carry hydrogen equipment (See Fig. 14.) into the field caused this marking system to be abandoned.

(5) Other: Several other methods such as flares, flags, etc. were tried and discarded due to either difficulty in discernment by the pilot or other peculiarities.

(6) Recommendations: It is recommended that smoke grenades to be used as markers be provided for the 1947 insect control season.

That further tests be conducted with various radio sets in order to find a set that can be used for air-ground communication.

6. PROJECT REQUEST:

A. Spray Request Outline: An outline of information to be included in all project requests was prepared in early 1946. This outline provided for submission of the following data:

(1) Name of installation, data, nearest operational Army Air Field.

(2) Topographical data including topographic and recent aerial maps of scale 1/12500 to 1/25000 of area to be sprayed and surrounding terrain, total area of post, area requiring control, number of acres to be sprayed and location on map, type of terrain, type of vegetation, number of structures in area to be treated, and flight hazards.

(3) Entomological data including mosquito abundance giving period of survey, number of adult resting stations, light traps, biting collection stations and larval collecting stations consistently used; numbers of malaria-transmitting adults and larvae collected during survey period; numbers of principal pest mosquitoes caught; location of collecting stations; abundance of other insect pests and vectors.

(4) Medical data including average strength of troops and civilians by month for two months preceding request; number of cases of locally contracted malaria hospitalized during preceding year; number of cases of malaria not locally contracted, hospitalized during preceding year; and incidence of malaria in local civilian population.

B. Recommendations:

(1) That a similar outline be used for project requests in future spraying operations with the following changes:

a. Change "nearest operational army air field" to read "nearest army air field".

b. Request recent aerial maps of the scale 1/7,000 to 1/12,500. (COMMENT: It is believed that aerial photographs of this scale can be obtained through the application of AAF Reg 20-35 or AAF Reg 95-8).

c. Omit request for size of post, and number of structures in area to be sprayed.

(2) That action be taken to reduce the time required to route projects through channels. A major handicap experienced at the beginning of the season was the unwarranted time interval between the projects departure from the initiating installation and its arrival in Squadron D. The shortest time any project took to reach Squadron D after its initiation was 31 days, while most projects took between 50 and 60 days and the average was 54 days. Even if the most recent data had been included in the project requests, by the time the project reached Squadron D the entomological data contained therein would have been too old to represent a true picture of the existing problem. By the time the number of days needed for shipping the DDT to the post is added to the time needed for the project to reach Squadron D, the total is quite impressive. Example: Fort Leavenworth--Project delay 68 days plus shipping time 15 days gives a total of 83 days. It is recommended that all concerned with the handling of the projects be properly impressed with the need of expediting them in order that they may reach the operational agency as soon as possible.

(3) It is recommended that aerial spray requests be handled under three categories with regard to the number of treatments which probably would be needed at each installation. Assignment to category would be made by the Engineer (Repairs and Utilities) of the appropriate Army or major Army Air Forces commands. The division could be set up as follows:

a. Category 1. Requests from those posts which from past experience and records can be expected to have a mosquito problem throughout the entire season of sufficient proportions to warrant successive DDT treatments by plane at specified intervals. After a Category 1 request had been approved the operational agency could requisition sufficient insecticide for the post for the entire season and set up a schedule of treatments for each post.

b. Category 2. Requests for a single application from posts which might have an unusually high density of mosquitoes for a short period or semi-emergency period where ground mosquito control crews fail to control the mosquitoes due to very favorable short period breeding conditions or other reasons. Category 2 requests should include entomological data covering a four week period immediately prior to the date of its initiation. The insecticide for category 2 requests would be requisitioned from the ASF Depot handling the insecticide immediately upon receipt of the approved request and spraying would be accomplished as soon thereafter as possible without interfering with the Category 1 schedule. In case a re-treatment becomes necessary at a category 2 installation, approval for re-spray would rest with the Army or AAF Headquarters having jurisdiction over the post requesting re-treatment. If approved the request for additional treatment would be forwarded direct to the operational agency.

c. Category 3 would include only emergency treatments for the purpose of curbing an epidemic. Category 3 request could be expedited by the use of telephone or TWX and would be given No. 1 priority by the operational agency. Insecticide could be ferried by air from the unit's base to the spray site. The situation being of an emergency nature, entomological and biological data could be dispensed with at the discretion of the appropriate insect and rodent control office (AGF or AAF).

7. OPERATIONS AND TECHNIQUE:

A. Determining the amount of insecticide to be requisitioned: Immediately upon receipt of an approved project, it was reviewed in order to determine whether or not aerial spray could be accomplished efficiently on the areas marked for spray by the requesting post. In most cases these areas had to be revised somewhat in order to lay out rectangular or square areas, the longest dimension of which should not be less than 1 mile long. Areas necessitating spray flights less than one mile long cannot be efficiently treated with large aircraft as too great a proportion of the flight time is consumed in making turns. This operation of reworking the boundaries of separate areas was done in most cases with the assistance of one of the squadron entomologists in order to include as much of the area appearing to breed mosquitoes as possible. After the areas had been laid out in such a manner that they could be sprayed efficiently, the acreage was calculated and insecticide was requisitioned on the basis of 0.24 pounds of DDT per acre plus a safety factor of 2 barrels. Excess spray not used at project was ferried back to Greenville Army Air Base and stored for future use.

B. Requisitioning the insecticide:
The insecticide is requisitioned direct from the Atlanta ASF Depot and ordered shipped to the post in care of the Post Engineer. The depot, at the time the requisition is placed, informs Squadron D of the date the shipment should arrive at the spray site. Movement to the spray site airfield was usually accomplished shortly after acknowledgment of receipt of the insecticide by the Post Engineer.

C. Notifications:
As soon as a tentative spray date had been decided upon, notification of that date was sent to the post concerned, army entomologist concerned, Hq Chief of Army Engineers, and any other agencies who had previously notified the organization of their interest in the project. A few army entomologists have stated that they did not have sufficient advanced notice to make proper arrangements, and accomplish necessary travel. Although an effort was made to notify all concerned one week or more in advance, this was not always possible due to existing circumstances i.e.: delay in receipt of project request, uncertainty of date of arrival of insecticide at spray site, postponement or cancellation of project, and an effort on the part of Squadron D to accomplish as many spray missions as possible during early part of the season. The fact that it was impossible in all cases to forward sufficient advance notice of intention to spray undoubtedly contributed to the result that very little or no entomological data was obtained from some posts. Should the project requests be handled as recommended in section 6, it is believed that it would be possible to set up a definite spray schedule for the posts concerned well ahead of the spray date thus eliminating this undesirable situation.

D. Movement to the spray-site airfield:
All personnel participating in aerial spray operations, with a few exceptions in the case of the entomologists who, when the situation warranted, traveled by rail from one post in the general area to another, were flown to the army air field nearest to the installation to be treated from one to three days before actual spraying was to be started. In event the nearest of the army airfields. was inactive, a letter authorizing the use of the field was obtained from Hq Third Air Force. No difficulty was experienced in obtaining this authority since Hq Third Air Force and the operational agency were stationed on the same field; however, some delay could be expected should the units be separated during the next season. Actual movement by plane was accomplished on Special and Operations Orders authorized by Hq Greenville Army Air Base, South Carolina.

E. Ground work accomplished in conjunction with spray-post personnel:
Immediately upon arrival at the post, the Post Commander, Engineer, or Surgeon was contacted. After explaining the mission, the spray

crew were generally referred to the agency handling the project for that particular post. A conference was usually arranged. Personnel attending most of these conferences were: Post Engineer or Post Surgeon or both, Post Sanitary Officer, and the Entomologist and pilots from the operational agency. As a result of these conferences, the following was accomplished: a general discussion of the project, discussion of the areas to be sprayed, re-arrangement of the areas to meet the approval of the post, arrangement for transportation and assistance needed, the insecticide is located and sent to the aircraft, and a decision as to the actual time of spraying is worked out. After or during the informal conference, the Entomologist and the Post Sanitary Officer worked out the problem of collecting entomological and biological data, while the pilots supervised the loading of the aircraft. The decision is reached as to the direction of flight runs over each area the afternoon or evening prior to spraying. This decision is based upon the forecast of the wind direction and velocity obtained from a weather office. The pilots then prepare their map by drawing flight lines on the map to represent each spray run over each separate area. Even though ground markers are used, it has been proven by past experience that the pilots can obtain a more even coverage by using a properly marked map in conjunction with the markers. Briefing of the ground marker crews was conducted by the pilot or entomologists on either the evening before spraying or immediately before take-off, or both, depending upon the difficulties which are expected to be encountered. Since an air-ground communication system was not perfected by the unit, these pre-spray briefings are very important to the success of the project as the pilots rely a great deal upon the correct placement of the ground markers. Wherever possible ground signals consisting of a marked vehicle or 2 minute smoke grenades were used on both ends of spray areas to designate 100 yard swath intervals to the aircrew spraying the area. Designated starting points for each of the marking crews was located by the use of an aerial photograph or map and by actually visiting the area. Crews were trained to set off the grenades on each spray run well ahead of the arrival of the aircraft overhead to permit the smoke to rise to a heighth at which the pilots can see it from the opposite end of the area and be able to fly towards it. Ground marker crews must also keep in mind the fact that when a smoke grenade is set off in groves of tall trees or behind a building, the pilots cannot see it until almost overhead. In this situation the interval should be extended past the obstruction or, if this is impracticable, the grenade should be set off on a knoll if one is nearby.

F. Actual spraying:

Actual spraying is generally accomplished through the use of a back and forth spray pattern advancing over the area in 100 yard intervals. However on some of the smaller areas a rectangular pattern was used which permitted spraying only in one direction. The spray pattern used is left to the discretion of the pilot who should, before making his decision, take into consideration the following: (a) the

length of the spray runs, (b) whether or not ground markers can be used, and (c) in the absence of ground markers, the adequacy of the map or photograph provided. (See discussion of maps and photographs under heading of project requests.) Regardless of the pattern to be used it is essential that ground marker crews, if used, have knowledge of the intentions of the pilot to prevent confusion which probably would result in incomplete coverage. Spraying is accomplished at a heighth of from 125 to 175 feet above the terrain. The most consistent coverage is acquired at a heighth of 150 feet; however, it is impossible by judgment alone to maintain this precise altitude. In order to obtain 100 yard swath coverage with sufficient overlap to insure complete treatment it is necessary to spray when the wind is from 3 to 10 MPH and blowing at an angle of 25 degrees or more to the line of flight. If the wind velocity approaches 10 MPH, complete coverage can be obtained if the wind angle is slightly less than 25 degrees. On the other hand if the wind velocity is very slight, the wind angle should be greater, probably between 35 and 90 degrees.

G. Time required for treatment:

The average acreage treated in one hour spraying time was 1,900 acres. This figure of course will vary with the technique of each individual pilot and the length of the areas being sprayed.

INSTALLATIONS TREATED AND APPLICATION DATA

PROJECT	APPLICATION	DATE PROJECT RECEIVED	DATE SPRAYED	GALS USED	ACRES SPRAYED	DOSAGE LB./A.	FLYING SPRAY TIME
MACDILL	1ST.	3	11 JULY	1050	6250	0.186	3:35
FIELD	2ND.	JULY	8 AUG	1045	6150	0.263	3:05
FLORIDA	3RD.	46	27 SEPT	1045	6150	0.263	2:25
HUNTSVILLE ARSENAL,	1ST.	14 JUNE	20 JUNE	900	6100	0.229	4:00
ALABAMA	2ND.	1946	29 JULY	935	6300	0.230	3:15
FORT LEAVENWORTH,	1ST.	8 JULY	11 JULY	660	4250	0.242	2:35
KANSAS	2ND.	1946	20 AUG	880	5722	0.238	2:30
EDGEWOOD ARSENAL,	1ST.	27 JUNE	16 JULY	510	3890	0.203	2:20
MARYLAND	2ND.	1946	14 AUG	560	3230	0.269	2:15
FT. KNOX, KENTUCKY	1ST.	8 JULY 46	23 AUG	1600	8900	0.245	4:15
CAMP POLK, LA.	1ST.	8 JULY 46	25 JULY	735	4690	0.243	3:50
TYNDALL FIELD, FLA.	1ST.	11 JUL 46	7 AUG	1450	11000	0.204	4:50
SAVANNA ORD., ILL.	1ST.	11 JUL 46	7 AUG	880	6200	0.220	4:25
FT. RILEY, KANSAS	1ST.	8 JULY 46	21 AUG	962	6235	0.239	3:35
FT. BENNING, GA.	1ST.	3 JULY 46	19 JULY	650	4157	0.242	3:15
TOTALS	15			#13862	89224		50:10
AVERAGES						0.232	

NOTE: #INCLUDES 650 GALLONS OF 5% DDT SOLUTION OBTAINED LOCALLY.
(400 GALLONS AT MACDILL FIELD, FLA., AND 250 GALLONS AT FT. KNOX, KY.)

8. ENTOMOLOGICAL ASPECTS:

A. Equipment:

Since spray equipment had not been tested or rate of flow calibrated prior to receipt of planes by Squadron D, precision tests were conducted to obtain as much knowledge as possible on flow rates, swath width, coverage and deposition of DDT per acre. Water was used in all tests except one to conserve insecticide.

(1) Flow rate tests:

Aircraft C-47 15565. Discharge pipe 7/8 inch inside diameter. Two tests were made and the average discharge rate indicated that the plane flying at 160 MPH would give an application of 0.239 pounds of DDT per acre, using the 20 percent solution. The average rate of application obtained by this plane for the season was 0.232 pounds of DDT per acre.

Aircraft C-47 16093. Discharge pipe 1-1/3 inches inside diameter. Three tests at various speeds were conducted with this plane, with results as follows:

Plane speed	Estimated application of DDT per acre
120	0.70
160	0.47
180	0.40

(2) Swaths Widths:

A series of tests were conducted to determine the maximum effective swath widths. Four rows of microscopic glass slides, eleven slides placed fifty feet apart in each row, were laid at right angles to, and down wind from the line of flight. The plane, C-47 15565, flew at a speed of 160 MPH at 150 feet altitude. The wind velocity was 7 MPH. The angle of flight from the wind direction was approximately 85 degrees. Results were determined by visual observation of the number of spray droplets appearing on each slide. The maximum deposition of spray occurred over an area 100 to 400 feet from the line of flight.

(3) Particle size and deposition:

At the time the second spray mission was made at Edgewood Arsenal, the Technical Service of the Arsenal furnished oleophobic surface glass slides and porcelain plates for the determination of droplet particles size and the amount of spray deposited on the ground under varying types of cover. The latter was determined by a colorimetric method. Three sets of 14 plates each were placed at different locations within the area treated. The first set was placed in an open field, the second set on a road bounded on both sides by tall

trees, and the third set in woods with foliage cover ranging from moderate to dense. The glass slides were placed in the center of the plates located in the open field. The determination of results of these tests were to be made by the laboratories of the Technical Service at Edgewood Arsenal. A report of their findings has not been received to date.

B. Entomological data furnished with project request:

In all cases the data furnished as a basis for airplane spraying in 1946 was considered inadequate. One base furnished no data of any kind and the remaining posts supplied their information based on collections made in 1944 and 1945. Practically all requests omitted information on how and where light traps were operated and data on collections from resting stations. It was realized that in most cases, it would be impossible to collect and tabulate data for the spring and early summer of 1946, in time to submit request for spraying to be accomplished by Squadron "D". Under these circumstances, it was mutually agreed at the meeting held at Orlando, Florida to base all requests on records of previous years. However, it was evident from the season's results that mosquito problems at the various installations were far from identical in 1945 and 1946.

C. Entomological data desired for each project:

Collection records desired upon which results of each spray project could be evaluated are as follows:

(1) Biting tests: Night biters, tests made at dusk or shortly thereafter, preferable on exposed torso. Stand for five minute interval to attract mosquitoes, then expose torso five minutes and collect mosquitoes biting. Teams of two men, one man acting as bait and one to count mosquitoes. Collect mosquitoes by aspirator or collecting tube for identification.

(2) Adult collection stations. Utilize established light trap or resting stations on the post. Resting station collections should be made weekly for four weeks prior to spraying on four consecutive days prior to treatment, four consecutive days following treatment, one week after treatment, and twice a week thereafter for three weeks. If light traps are used, collections should be made on a daily basis for four weeks prior to and four weeks following treatment. Identification of species should be handled through regular channels for each post.

(3) Larval stations. Made weekly prior to spraying, day prior, day following, and weekly thereafter for four weeks. Report larvae by number per dip, giving indication of percentage of instars. List by number the Anophelines and pest mosquitoes.

Although a uniform method of collecting was desired, several factors made this impossible. Some of the factors were insufficient personnel to assist in the progress, lack of trained personnel on each post, the failure of post personnel to procure pre-spray and post-spray data, the lack of interest on the part of various post personnel, and the establishment of varying types of collection methods at posts prior to the receipt of the approved project request by Squadron D. It was the belief of Squadron D personnel that it would be better to continue methods already standardized by various posts, as results under those conditions would be more indicative of the effectiveness of the missions. However, if future projects of this type are planned, proper evaluation can be made only through a uniform method of collecting data at each post or base concerned.

D. Effectiveness of aerial spray application.

(1) Adult mosquito control

(a) Results of biting tests:

Biting tests were made on 13 of the 15 missions. However, tests made at Fort Knox, Fort Benning, and Camp Polk were discarded due to unseasonably cool weather or low densities of mosquitoes. Tests at Fort Riley and Savanna Ordnance were made by local personnel and the results have not been forwarded to Squadron D. No tests were made at Tyndall Field.

Results of Biting Tests made on Nine Missions
(Average number of bites per man per hour)

Post	Pre-spray		Post-spray		%
	No. tests	No. bites	No. tests	No. bites	Red.
Huntsville (1)	1	101	2	0	100
(2)	1	34	2	0	100
Leavenworth (1)	1	420	3	16	96
(2)	1	10*	2	14	0
MacDill Field (1)	1	253	2	30	89
(2)	2	486	2	81	83
(3)	1	251	2	28	89
Edgewood (1)	1	203	2	17	92
(2)	2	84	2	8	91

NOTE: *Unseasonably cool.

(b) Light traps and resting stations:

With the exception of five posts, collections from light traps and resting stations were made sporadically and without a definite system. For this reason it is very difficult to determine with any degree of accuracy the duration of effective control achieved by the aerial spray.

The following is a list of collections for twelve of the fifteen missions made during the past season. Figures as listed are average densities per collecting station for individual days covering a period of one week prior to treatment, four consecutive days following spraying, and the 1st, 2nd, and 3rd, weeks after treatment. These data are all that were available to Squadron D.

AVERAGE DENSITIES OF ADULT MOSQUITO AS SHOWN BY RESTING STATION AND LIGHT TRAP RECORDS BEFORE AND AFTER SPRAYING

Posts treated			Pre-spray					Post-spray						
			1st week	4th day	3rd day	2nd day	1st day	1st day	2nd day	3rd day	4th day	1st week	2nd week	3rd week
Huntsville	(RS)	(1)	9.5	-	-	9.3	-	0.5	-	-	1.7	5.1	6.1	6.4
		(2)	21.3	15.0	-	-	-	-	-	-	-	1.3	2.5	5.9
McDill	(LT)	(1)	-	-	-	-	226.0	14.0	-	-	-	11.0	259.0	-
		(2)	-	-	138.0	121.0	130.0	6.3	2.0	-	5.7	3.7	-	-
		(3)	-	25.0	37.0	21.0	-	-	12.0	11.0	-	-	-	-
Leavenworth	(LT)	(1)	20.6	-	-	25.0	30.0	2.4	1.8	-	0.0	3.2	2.2	-
		(2)	23.0	7.0	-	-	-	2.5	1.0	-	-	1.0	-	-
Fort Knox	(RS)	(1)	3.0	2.2	0.5	1.0	1.0	1.0	0.5	0.1	0.1	0.2	0.7	-
Savanna Ord.	(RS)	(1)	-	-	-	153.0	-	15.0	-	-	-	0.8	14.0	80.0
Camp Polk	(RS)	(1)	9.1	-	-	5.6	-	-	-	-	-	2.9	-	-
Edgewood	(LT)	(1)	204.3	143.7	143.7	144.5	44.5	22.5	52.5	14.6	16.0	24.9	17.7	35.0
		(2)	46.6	43.3	44.2	58.7	14.3	16.0	18.0	4.8	5.3	12.0	12.6	7.8

NOTE: RS INDICATES RESTING STATION
LT INDICATES LIGHT TRAP

The table on the preceding page converted to percentages shows the reduction of adult mosquitoes at the end of the periods indicated.

Post	Period following spraying						
	1st day	2nd day	3rd day	4th day	1st week	2nd week	3rd week
Huntsville (1)	95	-	-	-	66	35	33
(2)	-	-	-	-	92	87	68
MacDill Field (1)	94	-	-	-	96	14*	-
(2)	95	99	-	-	97	-	-
(3)	-	60	61	-	98	-	-
Ft. Leavenworth (1)	91	93	-	100	88	92	-
(2)	84	94	-	-	94	-	-
Fort Knox	33	66	93	93	87	64	-
Savanna Ordnance	91	-	-	-	99	92	49
Camp Polk	-	-	-	-	-	63	-
Edgewood (1)	89	74	93	92	88	91	83
(2)	66	61	90	89	74	73	83

NOTE: *Increase due to mosquitoes being blown on the base from outside breeding areas.

The effect of the aerial application of DDT on the adult mosquito population as reflected by light trap records at Edgwood Arsenal is shown by the following chart:

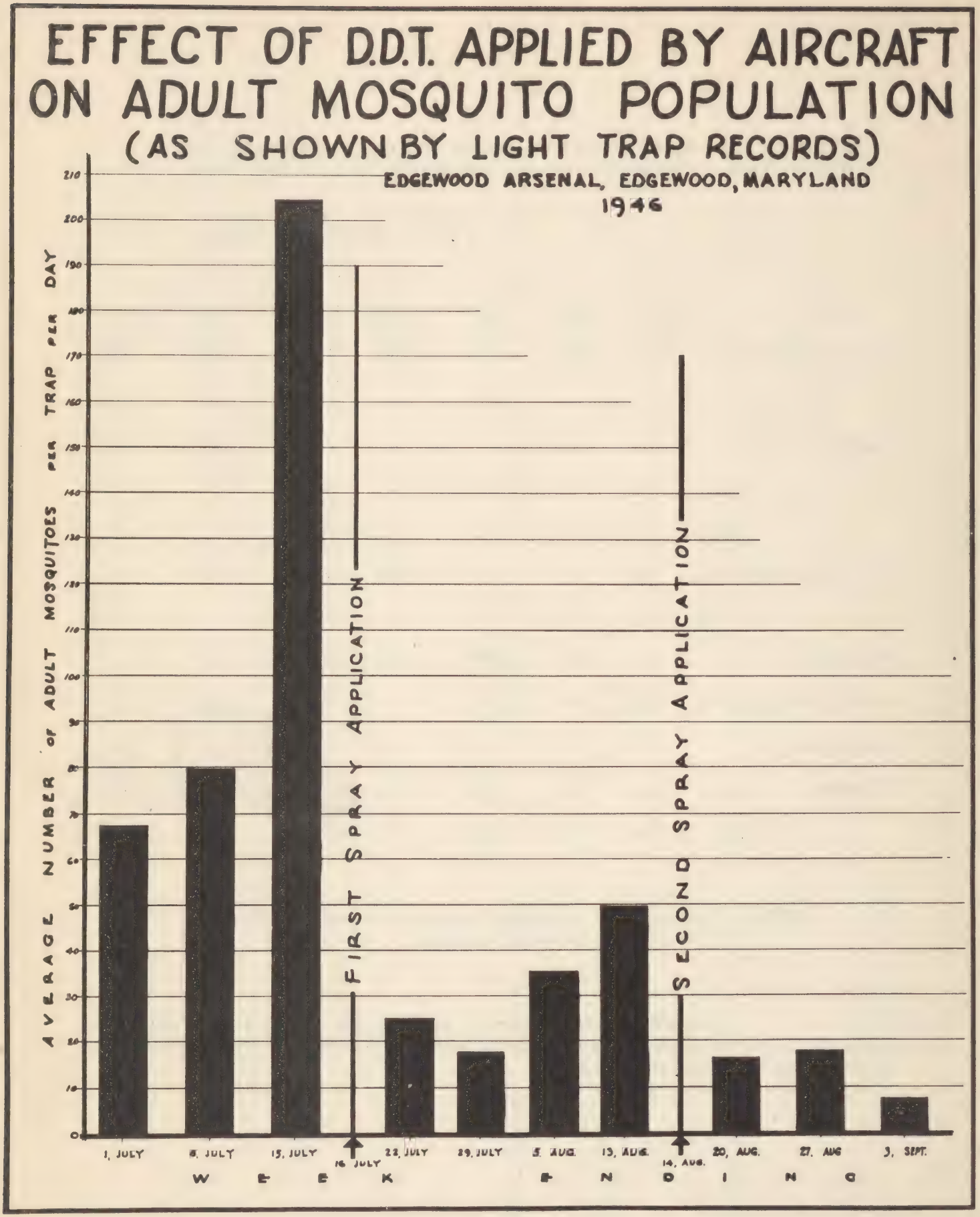
EFFECT OF D.D.T. APPLIED BY AIRCRAFT
ON ADULT MOSQUITO POPULATION
(AS SHOWN BY LIGHT TRAP RECORDS)
EDGEWOOD ARSENAL, EDGEWOOD, MARYLAND
1946
AVERAGE NUMBER of ADULT MOSQUITOES PER TRAP PER DAY
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
FIRST SPRAY APPLICATION
16. JULY
SECOND SPRAY APPLICATION
14. AUG.
1. JULY
8. JULY
15. JULY
22. JULY
29. JULY
5. AUG.
12. AUG.
20. AUG.
27. AUG
3. SEPT.
WEEK ENDING

Fig. 15

(2) Larval control:

Very little data was obtained on the effect of the DDT spray on larvae. In most cases it was impossible for Squadron D personnel to remain for more than one or two days on a base following aerial treatment. Consequently checks to be made on larvae were left as a responsibility of post personnel. Savanna Ordnance, Illinois and MacDill Field, Florida were the only posts which submitted records of pre-spray and post-spray data.

Larval Collections from Five Stations at Savanna Ordnance
(Recorded as larvae per dip)

	Pre-spray		Post-spray					
	5-7 August		8-9 August		13 August		23 August	
	Large	Small	Large	Small	Large	Small	Large	Small
Totals	23	56	0.4	0.0	0.5	0.5	3.0	4.0
Av/Sta	4.6	11.2	0.1	0.0	0.1	0.1	0.7	1.0

Larval Collections from Six Stations at MacDill Field, Fla.
(Recorded as larvae per dip)

	Pre-spray		Post-spray	
	7 August		9 August	
	Large	Small	Large	Small
Totals	18	0	0	0
Av/Sta	3	0	0	0

9. EFFECTS OF DDT SPRAYING ON WILDLIFE:

It can be safely stated that no serious initial kill or harmful lasting effects on wildlife resulted from spray operations at any of the posts treated during the past season. Representatives of the Fish and Wildlife Service Department of Interior were present at both treatments at Edgewood Arsenal, the first treatment at Huntsville Arsenal, Camp Polk, and Savanna Ordnance. At other posts all observations were made by personnel of Squadron D and the post receiving treatment.

10. COST OF AERIAL SPRAY.

A. In order that a comparison of the cost of aerial spray and ground control methods might be made the following information showing a breakdown of the estimated cost of each project was compiled. Costs included under the various headings are as follows:

(1) Overhead--expenses involved in preparation of reports, telephone calls, telegrams, etc.

(2) Insecticide--cost of insecticide required for treatment @ $1.14 per gallon.

(3) Salaries--salaries and wages for Squadron D personnel (other than crew members) present at each mission, and post laborers assisting in the mission.

(4) Transportation of Insecticide--freight charges from Atlanta Depot to spray site or estimated ferrying cost from Greenville Army Air Base to spray site.

(5) Ferrying the Aircraft--operating cost involved in flying aircraft from Greenville Army Air Base to and from spray site. Operating cost figure includes salaries of crew, fuel and oil, maintenance and depreciation of aircraft.

(6) Spraying operation--operating costs of flying aircraft for the actual time in the air to accomplish spraying at spray site.

(7) Transportation of Entomologist--rail transportation costs of travel made by entomologist of Squadron D to and from spray site.

(8) Total cost--totals of (1) to (8)

(9) Cost per Acre--total cost divided by number of acres treated at each post.

B. It should be borne in mind that average spraying per acre costs cannot be compared to the costs involved in treating an acre by ground control methods. Consideration must be given the fact that ground control methods are directed at mosquito breeding places, the total acreage of which is usually far less than that covered on an aerial spraying mission. In order to establish average costs of each method it would be necessary to obtain ground control cost for the past year or two for each post treated by air this year.

ITEMS OF COST

PROJECTS	OVERHEAD	INSECTICIDE	SALARIES	TRANSPORTATION OF INSECTICIDE	FERRYING AIRCRAFT	SPRAYING OPERATION	TRANSPORTATION OF ENTOMOLOGIST	TOTAL COST	COST PER ACRE
SAVANNA ORDNANCE 1ST SPRAY	100.00	1003.20	19.50	170.00	1050.00	662.50	NONE	3005.20	0.48
HUNTSVILLE ARSENAL 2ND SPRAY	100.00	1026.00	210.00	88.47	812.50	600.00	NONE	2836.97	0.47
HUNTSVILLE ARSENAL 1ST SPRAY	25.00	1065.90	46.40	60.00	475.50	487.00	NONE	2159.80	0.34
EDGEWOOD ARSENAL 2ND SPRAY	100.00	581.40	127.20	150.00	1025.00	350.00	44.64	2378.24	0.61
EDGEWOOD ARSENAL 1ST SPRAY	25.00	638.40	80.25	150.00	837.50	337.50	44.64	2113.29	0.65
McDILL FIELD 2ND SPRAY	100.00	861.00	75.80	NONE	900.00	537.50	21.99	2496.29	0.40
McDILL FIELD 3RD SPRAY	25.00	1191.30	69.25	NONE	700.00	475.00	21.99	2482.54	0.40
McDILL FIELD	25.00	1191.30	37.35	1020.00	950.00	362.50	NONE	3586.15	0.58
FORT KNOX	100.00	1615.00	99.00	175.00	575.00	637.50	30.00	3231.50	0.36
CAMP POLK 1ST SPRAY	100.00	837.90	84.35	180.00	1500.00	575.00	36.30	3313.55	0.71
FT LEAVENWORTH 2ND SPRAY	100.00	752.40	34.18	66.60	650.00	437.50	NONE	2040.68	0.48
FT LEAVENWORTH	25.00	1003.20	46.40	125.00	687.50	375.00	NONE	2262.10	0.40
FORT BENNING	100.00	741.00	23.20	33.00	450.00	487.50	NONE	1834.90	0.44
FORT RILEY	100.00	1096.68	14.37	104.40	889.58	375.00	NONE	2580.03	0.41
TYNDALL FIELD	100.00	1653.00	NONE	90.00	700.00	625.00	NONE	3168.00	0.29
TOTALS	1125.00	15257.68	967.25	2412.47	12202.58	7324.50	199.56	39489.24	0.44

CONCLUSIONS

1. The equipment as installed in aircraft assigned to this unit has worked satisfactorily.

2. The loading equipment used throughout the season, while not entirely satisfactory from a wastage standpoint, can be depended upon and could be used next season.

3. It can be concluded, in the absence of evidence to the contrary, that the dosage of DDT used this year (average of 0.23 pounds of DDT per acre) had no initial or lasting harmful effect on fish or wildlife.

4. A ninety percent (90%) average reduction in the population of mosquitoes in the areas sprayed was obtained. (Figured on only the nine (9) posts from which sufficient entomological data was obtained to arrive at a conclusion.) Estimate based on biting tests.

5. Data consisting of adult mosquito (resting stations and light trap collections) and larvae collections furnished this unit by the various posts treated were incomplete to the extent that an estimate on the length of effective mosquito control obtained per treatment could not be made with any degree of accuracy. However, it is concluded, based on data that was received, that the length of control obtained was approximately two (2) weeks. After this period the population of mosquitoes gradually increased. Post-spray data received by Squadron D for nine(9) applications indicates a ninety-one percent (91%) reduction in the mosquito population evident at the end of one (1) week. Data received for six (6) missions indicates a seventy-two percent (72%) reduction still evident at the end of the second week. Sufficient data was not made available beyond this two week period on which to base any further estimates.

FINAL RECOMMENDATIONS

1. It is recommended that a conference of all participating parties be held prior to the next spray season. Those present should include representatives from the Operational Agency, Office of the Chief of Engineers, Office of the Surgeon General, Headquarters, Army Ground Forces and Army Air Forces, entomologists from Army Areas and major Army Air Forces commands, and representatives from all A-3 sections of the various AAF headquarters that will handle project requests. This conference would be for the purpose of indoctrinating all concerned in the correct procedures for initiating, approving or disapproving, and the proper channeling and forwarding of these requests. By this method the handling and processing of all requests from the different army areas would be uniform.

2. It is recommended that the personnel now assigned to Squadron D be put on TDY with the AAF Committee on the Aerial Dispersal of Insecticides at Orlando Army Air Base, Orlando, Florida during the winter. During this time when there is no spraying going on they would be of invaluable help to the Committee in that they would be able to present all the information accumulated during the past season in the field. This information along with the technical work now being done by the Committee would be of value in testing new equipment and techniques. Squadron D personnel are the only ones acquainted with all the problems involved during the season's work. The Committee would be unable to obtain this information from any other source.

3. It is further recommended that additional experimental work be accomplished. It is believed that this should include the trial of different types of aircraft, spraying equipment, and loading equipment. If the type of insecticide is changed to the water dispersible DDT, as is believed will be the case at some future date, all of the equipment now in use will have to be changed. This experimental work could be carried out by members of Squadron D while on TDY to the AAF Committee on the Aerial Dispersal of Insecticides as recommended in paragraph 2 above.

4. It is recommended that the Operational Agency during any future spraying season be assigned to Headquarters, Army Air Forces and attached for rations, quarters, and maintenance to a base housing an Air Command or Air Force Headquarters. The reasons for this are numerous and are outlined below.

   A. The elimination of many time consuming channels, which proved to be such a detriment during the past season, would be of prime importance. It is imperative that the Entomological information be received by the Operational Agency without delay, thereby insuring accomplishment of each mission at an early date when maximum control can be achieved.

B. Due to the exceptional nature of the work involved the problems of supply cannot be easily or efficiently handled by the normal Squadron or Group Supply, but the supplies needed can be obtained from an AAF Depot without delay, which is of much importance during a spray season.

C. It is believed that the necessary coordination with other agencies (Armies, U. S. Public Health Service, United States Bureau of Entomology and Plant Quarantine, U.S. Fish and Wildlife Service, the various departments on a post requesting treatment, etc.) could be accomplished more efficiently from the Hq AAF level.

D. Many of the Air Fields used by Squadron D (over 30%) as a base during spraying operations were inactive fields. If a unit is stationed at a base on which there is no headquarters permitted to authorize the use of inactive fields, this could present quite a difficulty. It is important that the spray plane be dispatched immediately upon receipt of the approved project without having to wait for the permission request to be acted upon by a Headquarters located at some other field.

E. It is further believed that by having the unit at the high Air Force level it would insure greater cooperation in the collection and evaluation of important entomological information from the various army posts. The unit would be at the immediate call of the Air Force Headquarters and could be on the way to the scene of an emergency such as a high malarial incidence at an army installation or the outbreak of poliomyelitis in a matter of hours instead of days. It is believed that all this could be accomplished by making the unit a flight in the Air Force Flight Section.

5. It is recommended that at least 0.3 pounds of DDT per acre be applied during the next spray season to lengthen the period of effective control.

6. It is recommended that a standardization of methods of collecting entomological data be set up and adhered to during all future operations. This could easily be accomplished at the conference to be held before the season starts as recommended in 1 above.

7. It is recommended that the entomological data obtained by posts and operational information obtained from the Operational Agency be sent to a central agency for evaluation.

Fig. 16 Conducting Biting Test at
Fort Leavenworth, Kansas 20 August 1946

Fig. 17 Aerial Spray Fort Riley, Kansas
August 21 & 22, 1946

Fig. 18 Spray droplets observed on parked jeep after a spray run at Ft. Leavenworth, Kansas

Fig. 19 Quantity gauge installed by Squadron D on A/C #093

Fig. 20 Attaching discharge pipe to bottom of fuselage

Fig. 21 Aerial spray Camp Polk, Louisiana on July 25, 1946

Fig. 22 Aerial spray at Savanna Ordnance, Illinois 7 August 1946

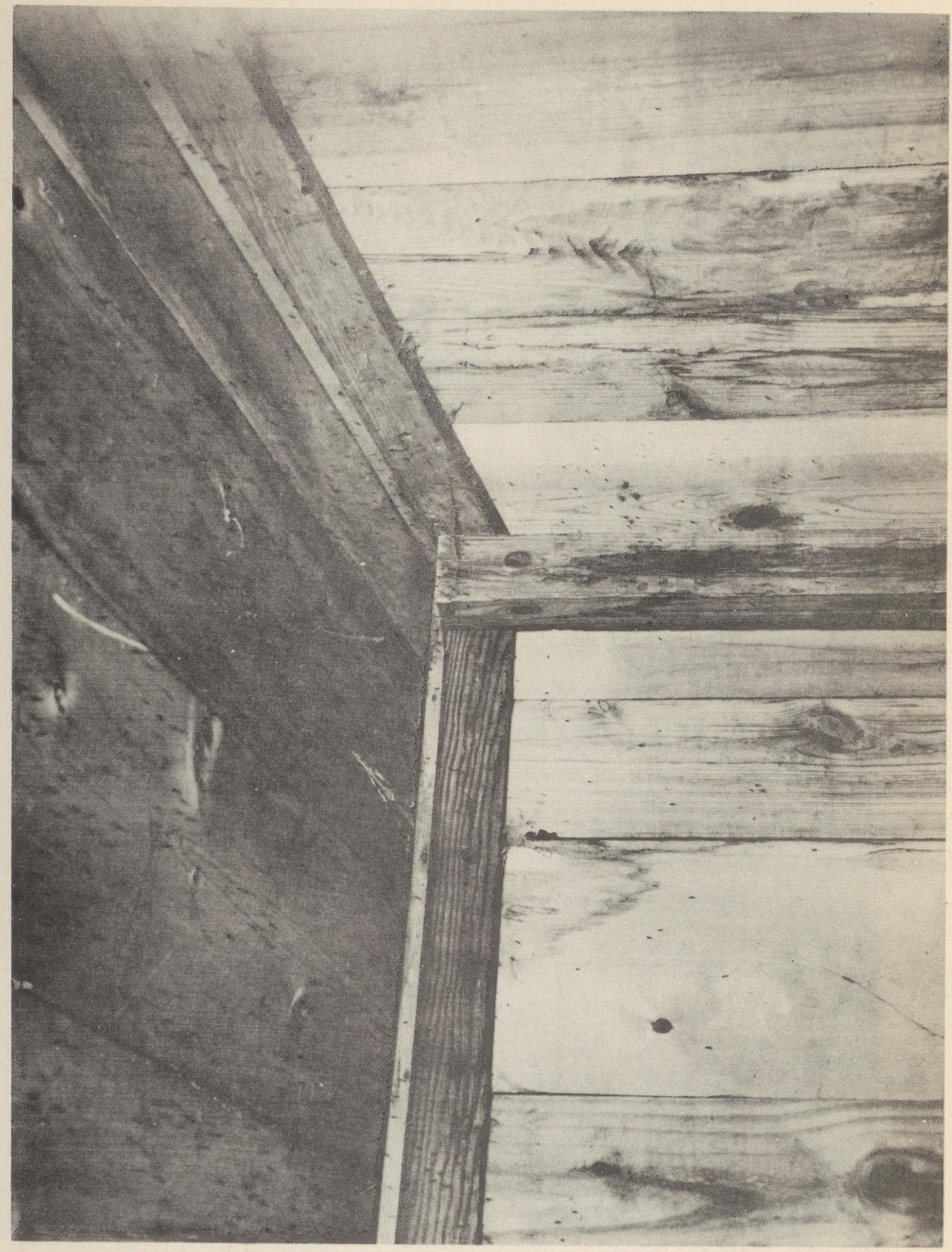

Fig. 23 Anopheline quadrimaculatus in privy prior to spraying at Savanna Ordnance, Illinois 7 August 1946

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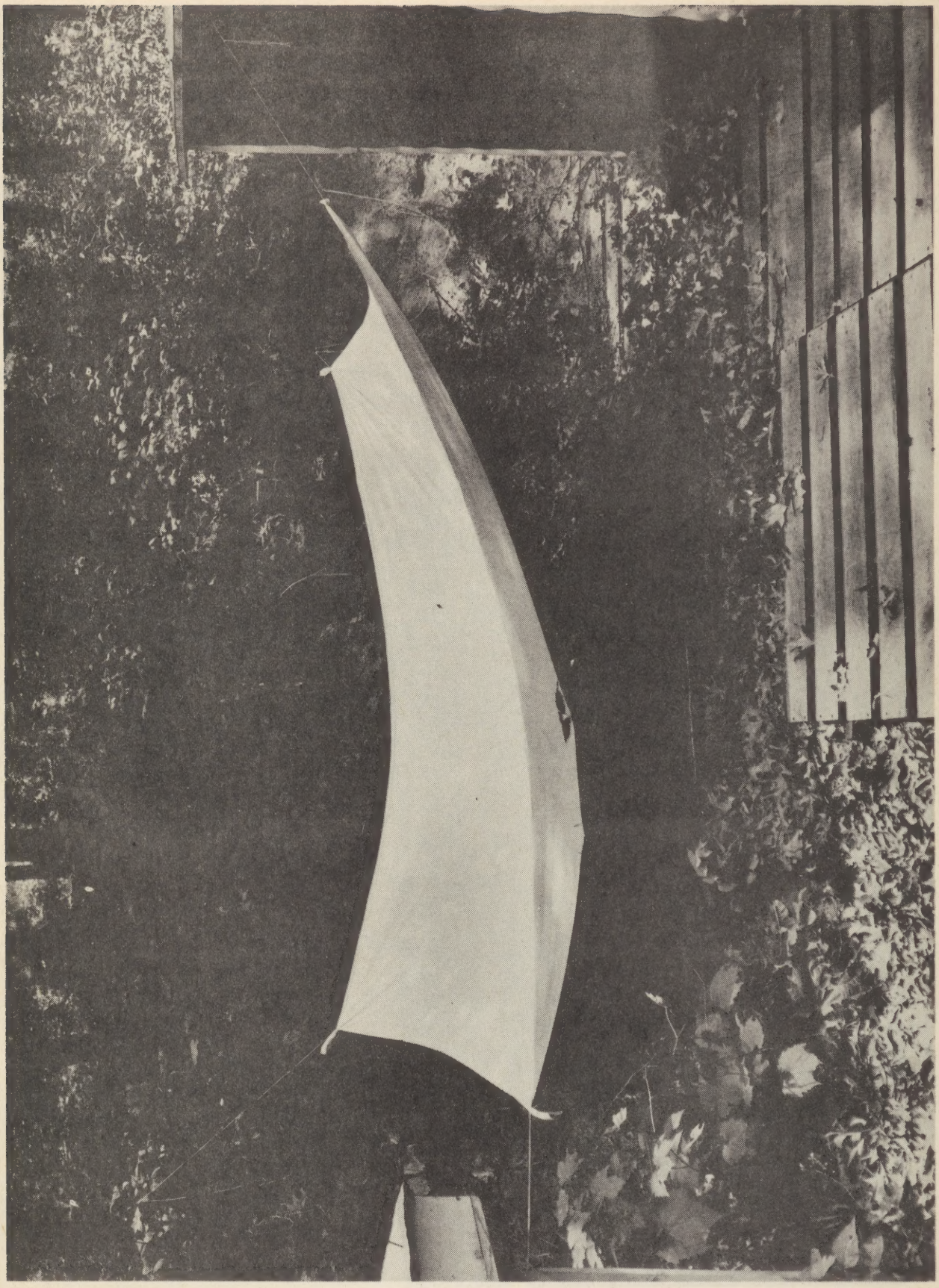

Fig. 24 Method of collecting falling insects effected by aerial spray.